Modernization of National Weather Service River Forecasting: Systems, Tools, and Models

AWIPS, NWSRFS, and FLDWAV in River Forecasting: Part of the Modernization of the National Weather Service

In the mid-1980's, the National Weather Service embarked on a major modernization restructuring. This modernization involved the development and deployment of the Automated Surface Observing System (ASOS), the development and deployment of the Next Generation Weather Radar (NEXRAD), and the development and deployment of the Advanced Weather Interactive Processing System (AWIPS). The total cost of this modernization and restructuring effort is approximately 4.5 billion dollars.

AWIPS is the "central nervous system" of NWS forecast operations and the information technology network that carries observations and data to NWS forecasters. With AWIPS in place, forecasters integrate and exploit all the data from the observing systems and numerical prediction models on one platform. AWIPS enables rapid diagnosis of hydrometeorological events, and generation of timely, accurate warnings of severe weather.

AWIPS, is the centerpiece of the modernization of the NWS and the center of operations at all 13 regional River Forecast Centers (RFC) and 122 modernized Weather Forecast Offices (WFO). AWIPS is also installed at several of the National Centers for Environmental Prediction (NCEP) locations including the Tropical Prediction Center (TPC), which specializes in tropical weather analysis and forecasts, and the Storm Prediction Center (SPC) which monitors and forecasts conditions that spawn severe thunderstorms and tornadoes. It is capable of receiving, processing, and helping the forecasters analyze the large amounts of hydrometeorological data, including river levels, rainfall potential, and other variables such as snow accumulation from:

1. River Gages

2. The network of NEXRAD Doppler Radars (WSR-88D)

3. The next generation of Geostationary Operational Environmental Satellites (GOES)

4. Other data sources such as Automated Surface Observing Systems (ASOS)

5. Forecast guidance produced at NCEP, NHC, and SPC

The AWIPS system is composed of two primary elements- the forecast component and the communications network.

The National Weather Service (NWS) River Forecast Centers (RFC) provide water resource and hydrologic forecast guidance to NWS Weather Forecast Offices (WFO)s at selected sites along the rivers and streams in their area of forecast responsibility. The main hydrologic forecast tool used by the RFCs is the NWS River Forecast System (NWSRFS). NWSRFS has been under continued development and enhancement for

close to 30 years. NWSRFS has been the NWS' operational model for hydrologic forecasting since the late 1970's. As AWIPS was implemented in NWS River Forecast Centers (RFCs) in the mid- to late 1990s, NWSRFS became an integral part of AWIPS for hydrologic operations. The NWSRFS consists of three components: the Calibration System (CS) , Operational Forecast System (OFS), and Enemble Streamflow Prediction System (ESP):

The Calibration System (CS) allows forecasters to determine model parameters for one forecast point. It runs the hydrologic models using historical data for many years for the forecast point. The user can then compare the historical observed and simulated streamflow and make adjustments to the model parameters to get the simulation to match the observed as best as possible.

On a daily basis, hydrologic forecasters use the Operational Forecast System (OFS) to provide short term (up to 30 days) streamflow forecasts. The OFS uses the model parameters determined with the Calibration System along with real-time and forecast precipitation, temperature, snow, river gage, and reservoir data to produce short term forecasts.

The Ensemble Streamflow Prediction System (ESP) generates streamflow traces which are used to create probabilistic river stage forecasts for the mid/long term time frame. It uses the current state variables of the models determined by OFS (i.e. initial soil moisture conditions) and the historical mean areal precipition time series for model inputs (precipitation, temperature, potential evaporation) to simulate streamflow for multiple forecast points.

In order to provide the means by which the hydrologic forecasters can take advantage of the AWIPS graphical environment, the NWS Hydrologic Lab has developed two programs, the Interactive Forecast Program (IFP) and the Interactive Calibration Program (ICP).

The Interactive Forecast Program (IFP) is a graphical user interface for the OFS. It allows the user to select the area and dates to use in an OFS run and produces a graphical display of the model outputs. The user can use the run-time modification capabilities of OFS through the IFP to make adjustments and quickly rerun the models and display the results.

The Interactive Calibration Program (ICP) is a graphical interface ad display program that works with the CS. The ICP displays the observed and simulated streamflow values, as well as precipitation. In addition, it can display the detailed information about the state variables for the Sacramento Soil Moistures Accounting Model (SAC-SMA). The extra detailed output allows the user to better visualize what is happening in the models over time and determine reasonable parameter changes to be made. The parameters can then be easily changed, the calibration rerun, and new results displayed.

All programs at the RFC use a single relational database known as the Integrated Hydrologic Forecast System Database (IHFS_DB). This ensures that all applications are utilizing the same data.

All these improvements allow NWS hydrologists to have more time to prepare river forecast products for distribution to an ever-increasing user community. By utilizing the tools of this new processing system to interpret and analyze water data from expanding information sets, AWIPS has enhanced the products and services the NWS provides.

The Advanced Hydrologic Prediction Service (AHPS), a program within the NWS hydrologic services program, provides new information and products through the infusion of new science and technology. This service improves flood warnings and water resource forecasts to meet diverse and changing customer needs. Improving flood forecasting and providing real-time flood forecasts maps is an essential part of the AHPS implementation. The current pilot study in North Carolina is using NWS modeling techniques to enhance river forecasting and provide flood forecast maps in a GIS environment. The hydraulic model used in this process is the NWS Flood Wave (FLDWAV) model, a component of the NWSRFS.

FLDWAV is a generalized flood routing (unsteady flow simulation) model that is an operation within NWSRFS and the AWIPS environment and receives data directly from NWSRFS, including inflow hydrographs (stage and/or discharge) for boundary conditions. The FLDWAV model calculates water surface profile elevations based on the St.Venant Equations for unsteady flow. FLDWAV is currently available in a standalone (PC) version and in operational mode on the HP-Unix environment of AWIPS. The operational model is what is used for forecasting flood stages. The direct connection to NWSRFS in AWIPS enables accurate, real-time data input and is calibrated to historical events and high water marks much like the Calibration System (CS) mentioned previously. The operational version of FLDWAV currently used for flood forecast mapping is one of many flood routing technique available in NWSRFS and AWIPS platform. Results from the execution of FLDWAV within the NWSRFS will be used to generate forecast inundation maps.